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Published in:

Book of Abstracts. DTU's Sustain Conference 2015

Publication date:

2015

Document Version

Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):

Bjørk, R., Nielsen, K. K., Bahl, C. R. H., Smith, A., & Wulff, A. C. (2015). Comparing superconducting and permanent magnets for magnetic refrigeration. In *Book of Abstracts. DTU's Sustain Conference 2015* [E-7] Technical University of Denmark.

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Comparing superconducting and permanent magnets for magnetic refrigeration

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We consider the initial cost of a high temperature superconducting (SC) tape-based solenoid versus a permanent magnet (PM) Halbach cylinder for magnetic refrigeration. Assuming a five liter active magnetic regenerator volume the price of each type of magnet is determined as a function of aspect ratio of the regenerator and desired internal magnetic field. It is shown that in order to produce a 1 T internal field in the regenerator a permanent magnet of several tons is needed or an area of superconducting tape of tens of square meters (see Figure 1). Assuming a cost of the SC tape of 6000 \$/m² and a price of the PM of 100 \$/kg, the superconducting solenoid is shown to be a factor of 1-3 times more expensive than the permanent magnet. However, this factor decreases for increasing field strength (see Figure 2), indicating that the superconducting solenoid could be suitable for high field, large cooling power applications.

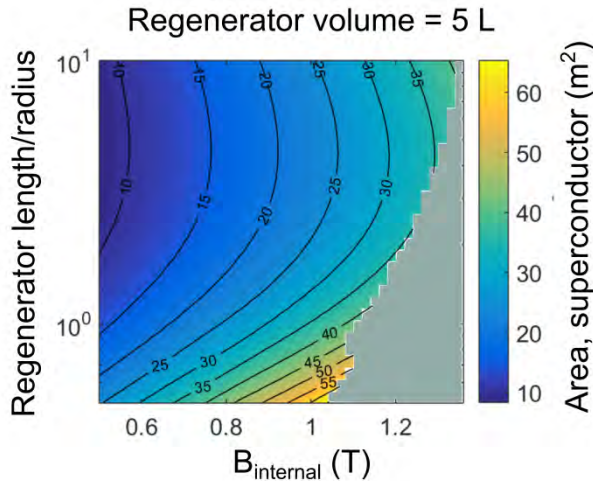


Figure 1: The area of the superconducting tape needed to produce a desired internal magnetic field for a given aspect ratio of the regenerator cylinder.

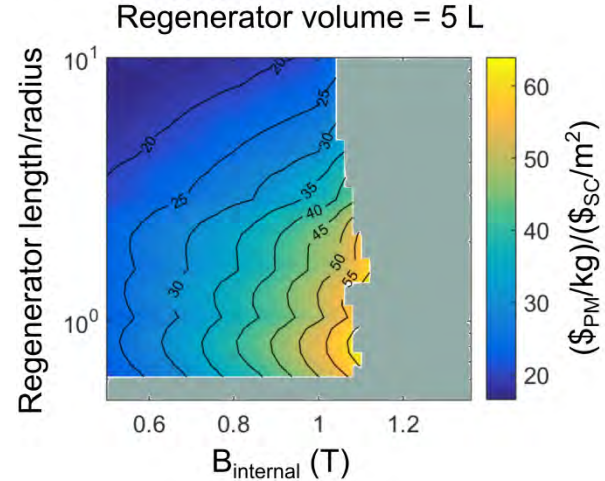


Figure 2: The factor between the price of the superconductor tape per m² and the price of the permanent magnet per kg.